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REPORT NO. FTDM-2195
DATE: 1 June 1962

MATERIAL - CADMIUM - VACUUM PLATED - FOR HIGH STRENGTH STEELS - EVALUATION OF CORROSION PROTECTION

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CONVAIR
FORT WORTH

Department 6
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TEST DATA MEMORANDUM

F TDM NO. 2195
MODEL B-58
TEST NO. F-8114

TEST: MATERIAL - CADMIUM - VACUUM PLATED - FOR HIGH STRENGTH STEELS - EVALUATION OF CORROSION PROTECTION

OBJECT: To determine the following:

(1) The salt spray corrosion resistance of vacuum cadmium plated 4130 steel before and after supplementary chromate dip per MIL-C-8837 (ASG).
(2) The effects of galvanic corrosion on assemblies of vacuum cadmium plated steel joined to magnesium-thorium.

TEST SPECIMENS AND PROCEDURE: The materials and equipment used for testing the specimens are listed in Table I. The test was conducted in accordance with the procedure given in Table II.

RESULTS: The results of salt spray tests on vacuum cadmium plated 4130 steel and vacuum cadmium plated 4130 steel joined to mag-thorium alloy specimens are given in Tables III and IV and shown in Figures 1 through 4. Table V gives the operating conditions for the salt spray chamber during specimen exposure.

DISCUSSION: The vendor was requested to vacuum cadmium plate 4130 steel to a thickness of 0.0005" but the steel received only 0.0001" to 0.0002" plating thickness. The test request asked for 96 hours salt spray exposure. Since after 96 hours only minor corrosion had developed, it was decided to extend the salt spray exposure period to 250 hours. Table III shows that after 96 hours salt spray exposure only one vacuum cadmium plated 4130 steel specimen had corrosion present. This specimen had received no supplementary chromate dip prior to salt spray. Table IV shows that after 96 hours salt spray exposure Type "B" assemblies (with tin plated fasteners) exhibited no corrosion whereas Type "A" assemblies (with cadmium plated fasteners) exhibited one case of galvanic corrosion of the mag-thorium alloy and one case of corrosion of basis metal on vacuum cadmium plated steel. Since Type "A" and "B" assemblies differed only in the type of plating on their fasteners, it follows that tin plated fasteners are superior to cadmium plated fasteners in this type of assembly.

CONCLUSIONS:

(1) Vacuum cadmium plating with supplementary chromate dip per MIL-C-8837 (ASG) will give 4130 steel satisfactory corrosion resistance to 96 hours salt spray exposure. The 0.0001" platings without the supplementary treatment exhibit borderline cases in protecting the steel.
(2) In Type "A" and Type "B" assemblies (see Table IV for components) tin plated fasteners give superior protection to galvanic corrosion than cadmium plated fasteners. The assemblies using cadmium plated fasteners will not pass 96 hours salt spray exposure whereas those using tin plated fasteners passed 250 hours exposure.

The above tests were conducted between 15 November 1958 and 2 March 1959.

WITNESS:

BY J. L. Cozart
CHECKED E. W. Jones
APPROVED J E H K E Parsons

DATE: 18 March 1959
de

TABLE I

TEST SPECIMENS, MATERIALS, AND EQUIPMENT

ITEM	USE	SOURCE
(20) 4130 Steel Specimen each 25"x4.0"x0.040", Vacuum Cadmium Plated by Anadite, Inc., Southgate, Calif.	Test Specimens	MIL-S-18729 Convair Plant Stock
(6) HK31-H24 Mag-Thorium Alloy plus Dow 17 Treatment and two coats DC-XP214 Silicone Primer	Test Specimens	FMS-0046 ** Convair Plant Stock
(12) Nuts	Fasteners for Assemblies	AN-365-1032 Convair Plant Stock
(12) Bolts	" "	AN-3-3 Convair Plant Stock
Salt Spray Chamber (Operated as per FTMS 151, Method 811)*	Media for exposure of specimens	Ind. Filter and Pump Mfg. Co. Chicago, Ill.
Dermitron Thickness Tester	Check thickness of plated specimens	Unit Process Assemblies, Inc. New York 3, N. Y.
Enstrip 103	Electrolytic Stripper for Cadmium	Enthone Inc. 442 Elm Street New Haven, Conn.
Dow 17 treatment MIL-M-45202 (ORD) Type I, Class C	On magnesium test specimens	Dow Chemical Co. Midland, Mich.
DC-XP214 Silicone Primer	On fasteners and specimens	Dow Chemical Co. Midland, Mich.

* 20% salt spray
** For the .080 thickness, specification FMS-0046 requirements are the same as those for MIL-M-26075.

TABLE II

TEST PROCEDURE

Test panels of 4130 steel which had been vacuum plated with 0.0001" to 0.0002" cadmium by Anadite, Inc., Southgate, California, were examined using the following tests:

(1) 50 hour salt spray exposure in accordance with FTMS 151, Method 811, using three plated test specimens without supplementary treatment. If no evidence of white corrosion product or rust appeared after 50 hours exposure, the specimens were observed every 16 hours until 96 hours had elapsed or until severe corrosion developed.

(2) 50 hour salt spray test using three vacuum cadmium plated test panels which had been given a supplementary chromate dip in accordance with para. 3.7 of MIL-C-8837 (ASG) as follows:

(a) Chromic Acid --- 5 - 8 oz/gal
(b) Temperature --- Room
(c) Time --- 5 seconds
(d) Rinse in tap water

The specimens were observed as in (1) above.

(3) Three 0.080"x5"x8" test panels of HK-31 magnesium-thorium had two holes drilled in them with a No. 10 drill. These holes were mated with similar holes drilled in three vacuum cadmium plated steel panels which had been given the chromate dip treatment previously described. All couple components received corrosion protective treatments as specified in FPS-0060. The treatments were as follows:

(a) HK-31 - Dow 17 Treatment plus 2 coats DC XP214 silicone primer.
(b) Vacuum cadmium plated 4130 steel - 2 coats DC XP214 silicone primer on faying surface only.

The coated components were used to fabricate three galvanic couple specimens. Each couple was assembled using two fastener sets of AN 3-3 bolts dipped in wet DC XP214 and fitted with AN-365 nuts. The assemblies were then subjected to salt spray exposure for 50 hours. The specimens were observed as in (1) above.

(4) Three HK-31 magnesium-thorium test panels were coupled to three chromate treated vacuum cadmium plated steel panels as in (3) above with the exception that the fasteners used were first prepared as follows:

(a) The cadmium plating on the nuts and bolts was removed with Enstrip 103.
(b) Tin plate was applied per FPS-0030* in place of the cadmium.
(c) Fasteners were applied with wet DC XP214. The coupled systems were exposed to 50 hours salt spray. After 50 hours exposure the specimens were observed in 16 hour increments until 96 hours

*See page 7.

TABLE II (Continued).

(c) (Cont.)

had elapsed or until severe corrosion developed.

Electrical continuity tests were conducted on all couple systems in (3) and (4) above.

TABLE III

RESULTS OF SALT SPRAY EXPOSURE ON

PLATED STEEL COUPONS

SALT SPRAY EXPOSURE INTERVAL (HOURS)	4130 STEEL SPECIMENS WITH 0.0001" VACUUM CADMIUM PLATE, NO CHROMATE DIP			4130 STEEL SPECIMENS WITH 0.0001" VACUUM CADMIUM PLATE PLUS CHROMATE DIP		
	#1	#2	#3	#4	#5	#6
48	Rust at edges and middle of specimen	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion
96	See Figure 1	"	"	"	"	"
120	Mild rust on 20% of surface	"	"	"	"	"
168	Rust on 40% of surface	"	"	Rust at edges of specimen	"	Rust at edges of specimen
192	Rust on 60% of surface	"	"	"	"	Broad rust area in middle
250	See Figure 2	No visible corrosion	No visible corrosion	See Figure 2	No visible corrosion	See Figure 2

NOTE: Test request called out only 96 hours exposure to salt spray. The exposure time was extended because the majority of specimens exhibited no corrosion after 96 hours exposure.

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TABLE IV

RESULTS OF SALT SPRAY EXPOSURE ON CADMIUM PLATED STEEL--MAG-THORIUM ASSEMBLIES

SALT SPRAY EXPOSURE INTERVAL (HOURS)	TYPE "A" ASSEMBLY (SEE NOTE #1 BELOW)						TYPE "B" ASSEMBLY (SEE NOTE #2 BELOW)					
	#7		#8		#9		#10		#11		#12	
	STEEL	MAG-TH	STEEL	MAG-TH	STEEL	MAG-TH	STEEL	MAG-TH	STEEL	MAG-TH	STEEL	MAG-TH
48	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion	No visible corrosion
72	"	"	"	1st sign of corrosion	"	"	"	"	"	"	"	"
96	1st sign of rust See Fig. 1	"	"	Slight increase See Fig. 1	"	"	"	"	"	"	"	"
168	Rust on 40% of steel surface	"	"	Large pit in one local area	"	"	"	"	1st sign of rust on edges	"	"	"
250	Increased to 85% area See Fig 3	"	"	Hole thru specimen See Fig 3	"	"	"	"	Increased to 30% area See Fig 4	"	"	"

TABLE IV (Continued

NOTE #1:

TYPE "A" ASSEMBLY

(1) 4130 steel with 0.0001" vacuum cadmium plate plus 2 coats D.C. XP214 silicone primer on faying surface.

(2) HK-31 Mag-Thorium with Dow 17 treatment plus 2 coats D.C. XP214 silicone primer.

(3) Coupled with AN365 nuts and AN-3-3 bolts (both cadmium plated). Fasteners applied wet with D.C. XP214 silicone primer.

NOTE #2:

TYPE "B" ASSEMBLY

(1) and (2) - Same as in "A" assembly.

(3) Cadmium stripped from AN365 nuts and AN-3-3 bolts with Enstrip 103. Fasteners then tin plated 0.0005" per FPS 0030, and applied wet with D.C. XP214 silicone primer. (The treatment per FPS-0030 was as follows:
a. Water rinse.
b. Pickle for 15-30 seconds in HCl-- 50% by volume.
c. Water rinse.
d. Tin plate with standard sodium stannate plating bath.
e. Water rinse.
f. Dry and bake at 370° ± 25°F for 3 hours.)

CONVAIR
A Division of General Dynamics Corporation
(FORT WORTH)

Test No. F-8114
W. O. 575-17-506
Engineer J. L. Cozart
Prepared by J. L. Cozart

TABLE V

SALT SPRAY DATA AND RESULTS

Cabinet No. 2

REPORT NO. FTDM-2195
MODEL B-58
DATE 18 March 1959

	TEMPERATURE OF BOX °F	AIR GAUGE PRESSURE psi	TEMPERATURE OF HUMIDIFIER °F	SPECIFIC GRAVITY OF SALT SOLUTION	SPECIFIC GRAVITY OF FOG SOLUTION	ML. FOG/HR. COLLECTED IN 10 CM FUNNEL	pH OF SALT SOLUTION	pH OF FOG SOLUTION
MAXIMUM	97°F	12	110°F	1.157	1.152	1.2	7.2	7.2
MINIMUM	92°F	12	100°F	1.148	1.143	1.0	6.8	6.8

I. DESCRIPTION OF SPECIMENS AND/OR PARTS

Size: 2.5"x4.0"x0.040" - 5.0"x8.0"x0.080"

Alloy and Condition: 4130 Steel - HK-31 Mag-Thorium

Coating, Finish, or Plate: Vacuum cad. plate - Dow #17 plus DC XP214 primer

Edges Sealed With: Paraffin

Pre-Exposure Cleaning: Cadmium plated steel had M.E.K. wipe and vapor degrease

II. No. of Specimens: 12 (6 cad. plated steel and 6 assemblies)

III. Reason for Test or Use of Part: Corrosion resistance test for cad. plated steel and coupled systems

IV. Exposure Time: 250 hours

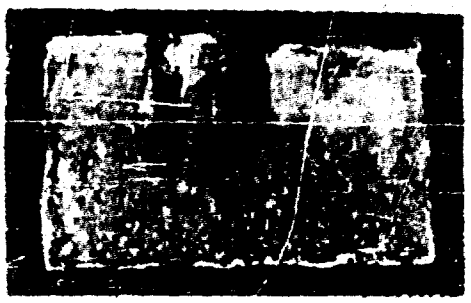
Date and Time in Chamber: 19 January , 1959

Date and Time out of Chamber 29 January, 1959

V. Method of Specimen Support: Suspended 15° from the vertical in non-corrosive plexiglass rack

VI. Results and Remarks: See report

INTERRUPTIONS			
DATE	TIME OPENED	TIME CLOSED	REASONS
			Salt Spray opened about 20 minutes daily to inspect specimens and take daily samples



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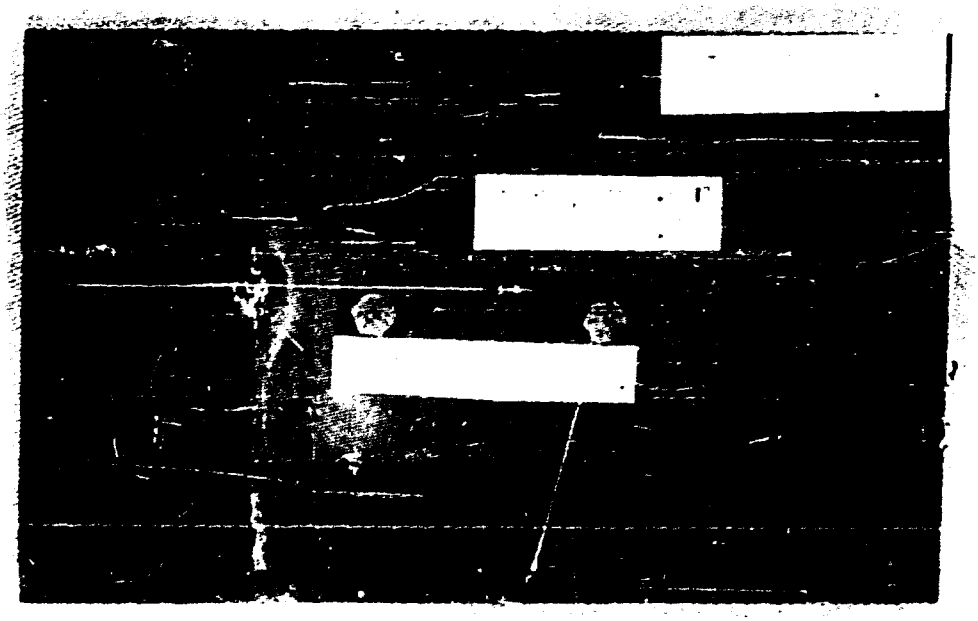

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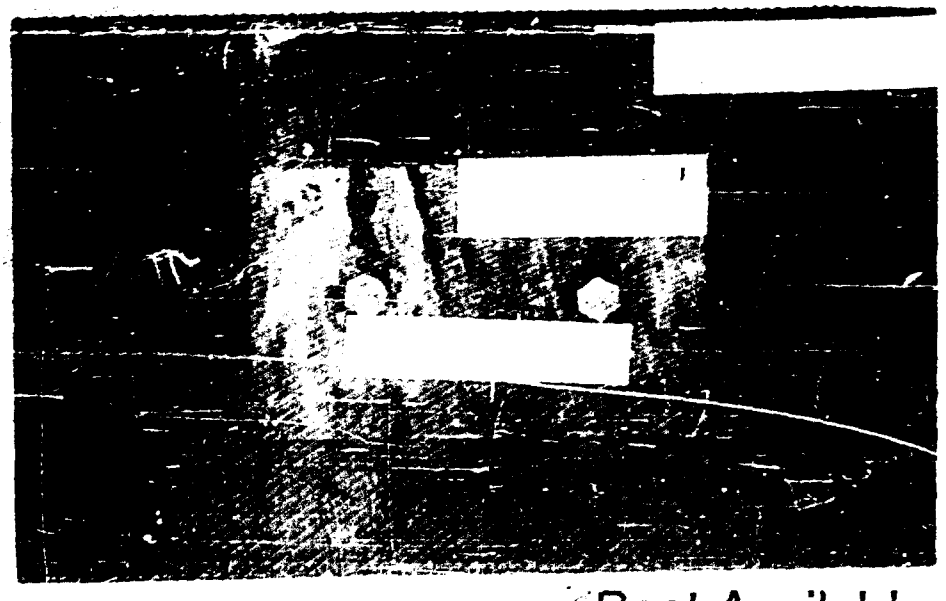

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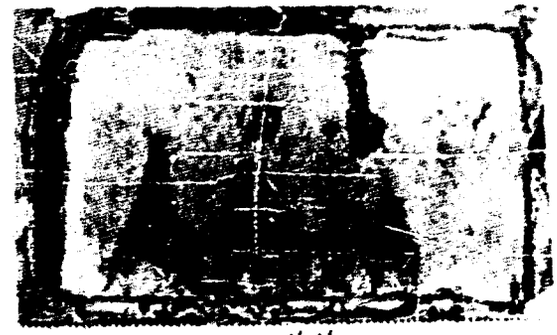
EFFECTS OF 250 HOUR SALT SPRAY EXPOSURE

#1



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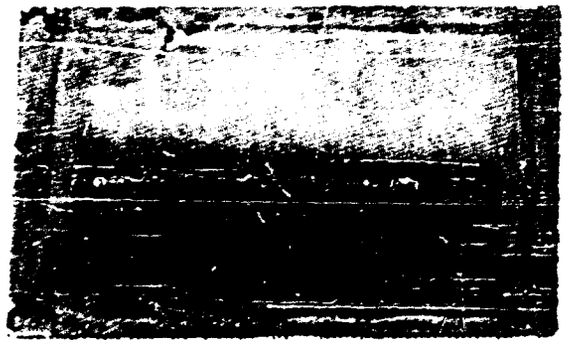

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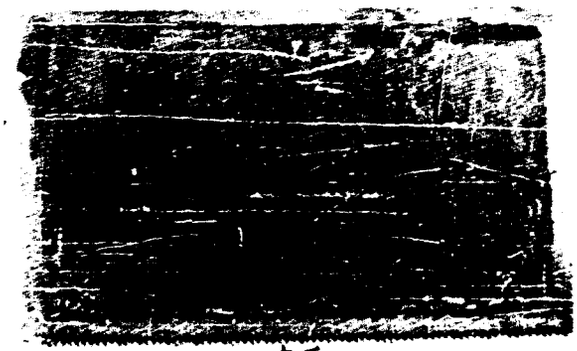

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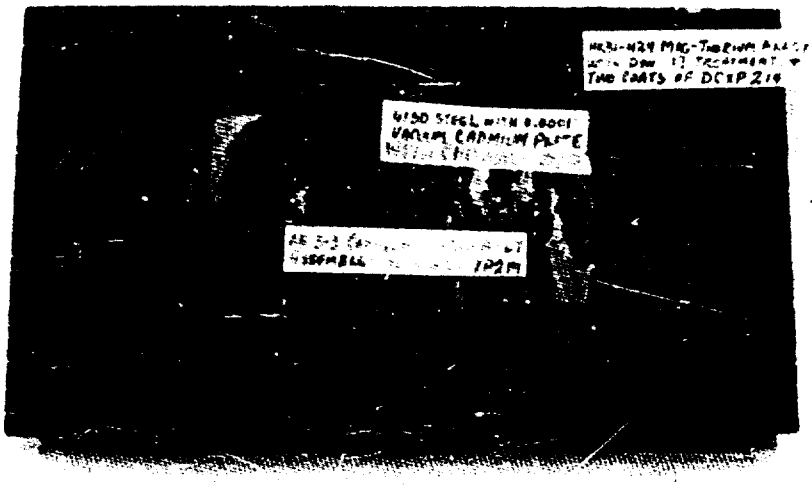

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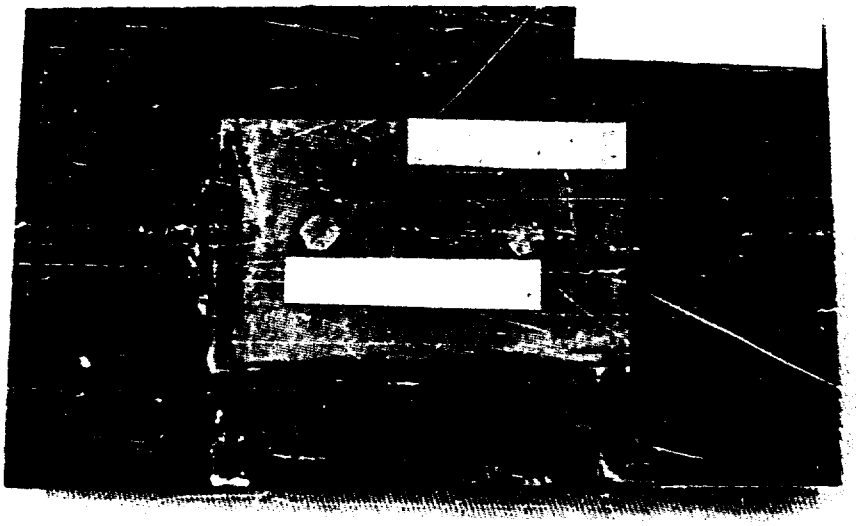

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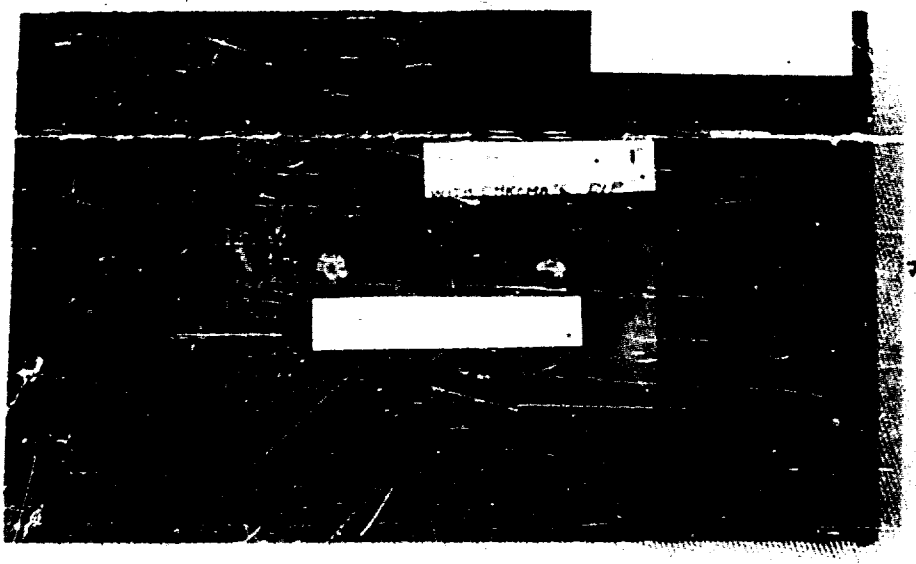

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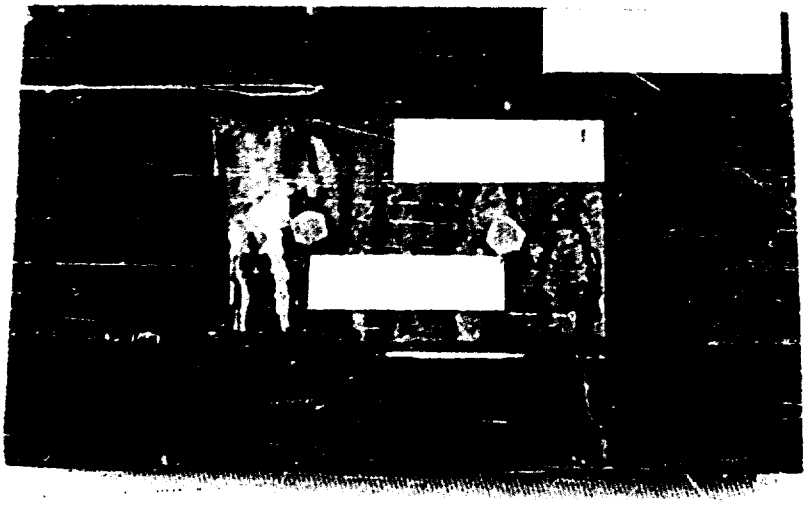
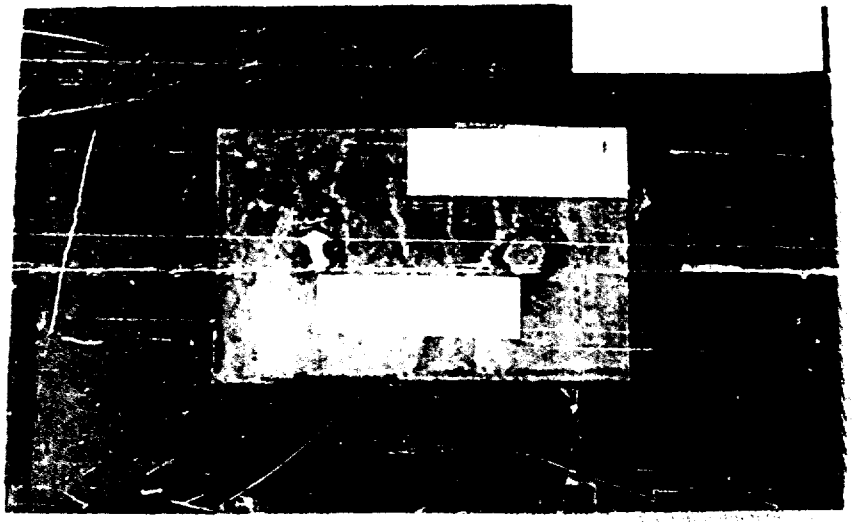
FIGURE 3

#10





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